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February 13, 2008

**BY HAND DELIVERY** **REDACTED – PUBLIC VERSION**

The Honorable Joseph J. Farnan, Jr.
United States District Court
844 North King Street
Wilmington, DE 19801

Re: *Voith Paper GmbH & Co. KG v. JohnsonFoils, Inc.*
*C.A. No. 07-226-JJF*

Dear Judge Farnan:

Voith respectfully submits this letter together with the declaration of Voith's Senior Vice President of Technology, Karl-Josef Böck (the "Declaration"), in response to the Court's request that the parties supplement the record of JohnsonFoils, Inc.'s ("JohnsonFoils") request for a stay. *See* D.I. 27 (JohnsonFoils' "Motion to Stay"), 33 (Voith's "Opposition"), 38 (JohnsonFoils' "Reply"); Declaration, Exh. 1. Specifically, at the parties' Markman Hearing, held January 30, 2008, D.I. 86, the Court asked for facts relating to the paper making machine business that would assist the Court to determine whether the harm to Voith GmbH & Co. KG's ("Voith") resulting from JohnsonFoils' continuing infringement ("Infringing Rebuilds") would likely be recoverable as purely monetary damages after an imposed stay is lifted. *See* January 30 Markman Hearing Transcript ("Hearing"), 103-104, D.I. 86. For reasons explained more fully below and in the attached Declaration, staying the present litigation at this time will very likely irreparably harm Voith by imposing significant losses that cannot be compensated by an award of monetary damages in the future.

As explained in detail in the attached Declaration, JohnsonFoils' accused activities result in harm to Voith which far exceeds the lost profit for charges directly resulting from performing the paper machine rebuilds at issue in this litigation—damages which may never be recoverable if the infringement is allowed to continue unabated. Declaration, ¶¶16-20. During the Markman Hearing, JohnsonFoils stated that the value of a contract to perform an accused rebuild is about [redacted]. Hearing, 108:10-11. However, even if this number is adjusted to reflect JohnsonFoils' [redacted] price reduction from the price customarily charged by Voith prior to the entry of JohnsonFoils' Infringing Rebuilds, the resulting monetary amount would not compensate Voith for parts and services often sold subsequent to performing a successful rebuild. Declaration, ¶¶1-2. JohnsonFoils' Infringing Rebuilds harm Voith by depriving Voith of the opportunity to make such sales. Moreover, even though the loss of such opportunities unquestionably harms Voith, such harms may not be compensable. In fact, at the Markman

Hearing, JohnsonFoils flatly asserted that damages from services provided in addition to the rebuild are "not available." Hearing, 108:15-18. *See* Verizon Services Corp. v. Vonage Holdings Corp., 503 F.3d 1295, 1310 (Fed. Cir. 2007)(affirming imposition of injunction, holding that record evidence of price erosion as well as lost opportunities to sell other services to the lost customers supports finding of irreparable harm); *Novozymes a/S/ v. Genencor Intern., Inc.*, 474 F. Supp. 2d 592, 612-613 (D. Del. 2007) (in a case involving head to head competitors, imposing a permanent injunction because cash royalty found inadequate compensation for the right to exclude).

In the paper machine and manufacturing market, additional machine, rebuild, parts, accessories, and service sales often result from performing a successful rebuild. To illustrate this well known feature of the paper machine and manufacturing market, the attached Declaration describes four specific cases. *See* Declaration, ¶¶17-20. In the first such example, Voith was chosen to perform a former rebuild at [redacted] a paper making machine owned by [redacted]. *See Id.* at ¶17. The cost of the core rebuild was [redacted]. *Id.* In addition to this core rebuild, [redacted] also purchased other parts and services totaling [redacted]. *Id.* Beyond those additional purchases, [redacted] also chose to purchase its [redacted] *Id.* Over a ten year period, these [redacted] sales would add up to an additional [redacted] in revenue. Taking these follow-on sales into account, and without taking into consideration other purchases, including other rebuilds and machine work, likely to result from performing the original successful rebuild, the cost of original rebuild is only [redacted] of the expected revenue that Voith would have lost had it not performed the original rebuild. *Id.*

A further example is provided by Voith's rebuild at [redacted] installation in [redacted]. *Id.* at ¶18. The core cost to [redacted] for this rebuild was [redacted]. *Id.* However, [redacted] made additional purchases of parts and services for [redacted]. *Id.* [redacted] also purchased [redacted] from Voith at a rate of [redacted] per year. Over a ten year period, these [redacted] purchases are expected to bring in revenue of [redacted]. *Id.* Thus, without regard to the possibility of subsequent parts and service sales, including other rebuilds or machine replacements, the core cost of the original rebuild is only about [redacted] of the expected revenue of [redacted]. *Id.*

Voith performed yet another rebuild for [redacted] at its [redacted] paper machine that resulted in the sale of a completely independent units and parts. *See* Declaration, ¶19. In addition to the core rebuild of the forming section to incorporate the teachings of the Patents-in-suit, [redacted] purchased a new [redacted] and parts for [redacted] section. *Id.* These additional purchases provided Voith with revenue [redacted] beyond [redacted] cost of the original requested rebuild. *Id.* Finally, the first such forming section to be performed by Voith for [redacted] resulted in the sale of a [redacted], namely the [redacted]. *Id.*

These examples demonstrate that JohnsonFoils' continuing infringement of the Patents-in-suit result in real harm, in the form of lost opportunities, to Voith. JohnsonFoils' representation that JohnsonFoils does not compete with Voith for these other sales, even if true, does not diminish the fact that, but for JohnsonFoils' infringing rebuilds, Voith would have more opportunities than it currently has to market its products and services to paper manufacturers.

Moreover, JohnsonFoils' representation that it does not compete with Voith for such additional sales does not hold up under close scrutiny. For example, even if "JohnsonFoils" does not compete with Voith in the market for paper machine fabrics, its parent, AstenJohnson does. AstenJohnson was formed in 1999 from Asten, Inc., a fabrics manufacturer, and JWI Group, which included JohnsonFoils. *See* Declaration, ¶8. The world market for such fabrics is estimated to be [redacted] annually. *Id.* Voith's estimated market share is [redacted] annually. *Id.* AstenJohnson's market share is estimated to be [redacted] annually. *Id.* As previously explained, each rebuild is an opportunity to sell [redacted] in fabrics for each subsequent ten year period. Declaration, ¶15.

JohnsonFoils' claim that it is not capable of competing with Voith for parts and services beyond "resiliently mounted blades" is especially misleading when viewed in the context of public statements made by its parent company AstenJohnson and JohnsonFoils' own disclosures relating to the Infringing Rebuilds. At the hearing, in response to a direct question from the Court about harm from subsequent sales of parts and services, JohnsonFoils stated that its competition with Voith is limited to manufacturing "resilient blades."

> The Court: He thinks you're sneaky. He thinks you're going to get other stuff when you get in there.
>
> Mr. Volpe: Actually, Your Honor, I'm certain if my client could get into the entire apparatus, they would do it. But there's one flaw in that argument. Voith builds the entire paper making machine. JohnsonFoils is a company that makes the resilient blades that we've been talking about. They never make a formation apparatus. They never make a dryer section. They never make a press section. They do not provide any dryer, press, or formation belts. They do not supply any of the rollers that go into the press section or the dryer section. These are pieces of equipment that Voith builds from the ground up as they've so eloquently noted in their briefs. They're $600 million machines. . . .

Hearing, 107:16 – 108:16 (emphasis added). Thus, before this Court, JohnsonFoils disavowed any competition with Voith on anything other than resiliently mounted blades. *Id.* By way of contrast, JohnsonFoils' parent company, AstenJohnson, portrays itself as a company which has "total machine clothing [,i.e. fabric, including forming fabrics,] and equipment capabilities." Declaration, ¶8 (emphasis added). In view of AstenJohnson's own marketing statements, the rebuilds offered by JohnsonFoils must be viewed in the context of the broader, "total," services offered by AstenJohnson. Viewed in that context of AstenJohnson's [redacted]

annual market share of the [redacted] business, JohnsonFoils' statement that JohnsonFoils does "not provide any dryer, press, or formation belts" is disingenuous.

Moreover, JohnsonFoils' own public statements about JohnsonFoils' forming section rebuilds—made at a conference within one week of the Markman Hearing, on February 6, 2008—contradict JohnsonFoils' statement that its own competition with Voith is limited to "resilient blades." *See* V.J. Wildfong, J. A. Shands, J. Ronning, et al. *Evaluation of Gap Forming Rebuild Options*[ ... ], PAPTAC 94th Annual Meeting, February 6, 2008, p. 3, Exh. 2. In its PAPTAC paper, JohnsonFoils described rebuilds which include "pre-couch HIVAC" and custom ceramic replacements in addition to the resiliently mounted blades. *Id.*

JohnsonFoils' further attempts to minimize the impact of its competition with Voith fail in light of the fact that the Infringing Rebuilds have had the effect of [redacted]. *See* Declaration, ¶¶9-10. Due to the cycle for rebuilding the forming sections of paper making machines, Voith expects there to be numerous opportunities to market rebuilds during the remaining term of the Patents-in-suit. *Id.* at ¶¶6, 10, 21. However, JohnsonFoils' Infringing Rebuilds, [redacted] JohnsonFoils ability to increase its market share by charging lower prices results from the fact that the technology and know-how for performing rebuilds was obtained from the teachings of the Patents-in-suit and the know-how of Voith personnel. *See* Declaration, ¶13. For example, as part of its plan to extend its parts business to the rebuild market, JohnsonFoils hired [redacted] *Id.* at ¶¶12-13; *see Imx, Inc. v. Lendingtree*, LLC, 469 F. Supp. 2d 203, 225 (D. Del. 2007) (injunction is supported by evidence that infringing component is a primary part of the system and the system mimics the patented system).

For similar reasons, the size of JohnsonFoils' workforce, purportedly numbering at [redacted], renders competition from JohnsonFoils' Infringing Rebuilds insignificant is irrelevant in view of JohnsonFoils' apparent ability to [redacted]. *See* Hearing, 108:23 – 109:9. Moreover, JohnsonFoils' parent company, AstenJohnson, a competitor of Voith in the [redacted] market, has 1800 employees and has a [redacted] market share. *See* Declaration, ¶8.

Staying this case, as proposed by JohnsonFoils, would unfairly permit JohnsonFoils to continue to exclude Voith with aggressive pricing on its Infringing Rebuilds until the patents expire in 2010. As explained in detail above and supported by the accompanying Declaration of Karl-Josef Böck, JohnsonFoils' Infringing Rebuilds continue to harm Voith in ways that extend [redacted]. While depriving Voith of these business opportunities, JohnsonFoils' position in the United States rebuild market unfairly hands these opportunities to others, including JohnsonFoils' own parent company, AstenJohnson, which markets itself as a total provider of parts and services relating to paper making machine fabrics and equipment. JohnsonFoils' apparent ability to [redacted]

flows directly out of aggressive pricing made possible by the fact that Voith, not JohnsonFoils, bears the cost for the research and development needed to bring the teachings of the Patents-in-suit to light. JohnsonFoils admits that these lost opportunities and revenues may not be compensable if this case is resumed after a lengthy delay.

For the foregoing reasons, Voith respectfully requests that JohnsonFoils' Motion to Stay these proceedings be denied.

Respectfully submitted,

Adam W. Poff (No. 3990)

AWP:mmeeh
Attachments

cc: Clerk, U.S. District Court (Redacted version by E-filing)
Anthony S. Volpe, Esquire (By E-mail)
Patricia McGonigle, Esquire (Redacted version by E-mail)
George H. Seitz, III, Esquire (Redacted version by E-mail)
Neil F. Greenblum, Esquire (By E-mail)
Michael J. Fink, Esquire (By E-mail)
Chad S.C. Stover, Esquire

# EXHIBIT 1

REDACTED VERSION

**IN THE UNITED STATES DISTRICT COURT**
**FOR THE DISTRICT OF DELAWARE**

| | | |
|---|---|---|
| VOITH PAPER GMBH & CO. KG,<br>a Company organized and<br>existing under the laws of Germany,<br><br>Plaintiff,<br><br>v.<br><br>JOHNSONFOILS, INC.,<br>a Delaware Corporation,<br><br>Defendant. | ) | C.A. No. 07-0226-JJF |

**DECLARATION**

1. I, Karl-Josef Böck, am currently employed by Voith Paper GmbH & Co. KG ("Voith"), and have been so employed since July 1, 1991. My present job title is Senior Vice President of Technology. I understand that as part of the above captioned litigation (the "Infringement Litigation"), Voith has asserted that JohnsonFoils, Inc. ("JohnsonFoils") infringes Voith's United States Patent Nos. 5,972,168 and 5,718,805 (the "Patents-in-suit"). I also understand that JohnsonFoils has requested that the Infringement Litigation be stayed and that such a stay would likely delay the adjudication of the Infringement Litigation for years and beyond the expiration of the Patents-in-suit. Moreover, I understand that such a stay would permit JohnsonFoils to continue its accused infringement of the Patents-in-suit. For the reasons more fully stated and explained below, such a stay would result in continuing losses to Voith that I am informed may not be compensated by a subsequent award of monetary damages. These losses include at least the lost opportunity to provide highly lucrative paper making machine

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products and services subsequent to and in addition to the rebuilds at issue in this Infringement Litigation.

2. In the course of my employment with Voith, I have become familiar with the structure of the paper manufacturing business including, paper making machines, paper making machine rebuilds, and related services and accessories. Although the subject matter of the Patents-in-suit relates to the forming section, called a Twin Wire Former, of a paper making machine, supplying or rebuilding a forming section of a paper making machine for a paper manufacturer customarily results in sales of other paper machine parts, services, and accessories to that manufacturer. Voith is a supplier of paper making machines, as well as parts and services for all sections of paper making machines, including the forming, pressing, and drying sections.

3. I estimate that, in 2007, the worldwide market for all paper making machine products and services exceeds [redacted]. The US market is [redacted] of the world market, and is estimated to exceed [redacted]. I estimate that there are approximately [redacted] formers in existence worldwide which [redacted] incorporates the technology disclosed in the Patents-in-suit.

4. Voith performed its first rebuild of a paper former to incorporate resiliently mounted counterblades to a forming section of an operating paper making machine for [redacted]. By [redacted], the technology disclosed in the Patents-in-suit, including resiliently mounted counterblades, became standard equipment on Voith's new paper making machines.

5. Although the technology of the Patents-in-suit had become standard equipment in Voith's gap former paper making machines by [redacted], the demand for rebuilding existing forming

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sections to incorporate this technology did not develop until recently. Because of the [redacted] rebuild cycle for forming sections, the market for rebuilding existing forming sections to incorporate the new technology did not [redacted] until around the year [redacted].

6. There are still approximately [redacted] paper making machines in operation worldwide for which a gap former rebuild [redacted] as disclosed in the Patents-in-suit is suitable, namely about [redacted] of which about [redacted] were originally built by [redacted] and marketed under the trade name [redacted]. Based on past market behavior and the number of currently operating paper making machines, I estimate that the world market for paper former rebuilds will continue at a rate of approximately [redacted].

7. JohnsonFoils, and its parent company AstenJohnson, Inc. ("AstenJohnson"), are direct competitors of Voith in the market for forming section rebuilds and forming section fabrics. Specifically, from publicly available information [redacted], I am aware that JohnsonFoils has made competing bids on "wet end" paper former rebuilds which are accused in this Infringement Litigation of infringing the Patents-in-suit ("Infringing Rebuilds"). JohnsonFoils is a United States company that manufactures its components in the United States and performs such Infringing Rebuilds at paper making machine installations worldwide, including installations in the United States.

8. JohnsonFoils' parent company, AstenJohnson, a U. S. company with approximately 1800 employees, competes directly with Voith in the market for paper forming fabrics. AstenJohnson formed in 1999 from a merger of Asten, Inc., a fabrics supplier, and JWI Group, which included JohnsonFoils, Inc. On its website, AstenJohnson characterizes itself as a company with "total machine clothing [, i.e., fabric, including forming fabrics,] and equipment

capabilities." I understand that paper forming fabrics are described in the Patents-in-suit as "wires" or wire belts, and are used to form the paper web in the wet-end of a paper forming machine. The current world market for such fabrics is approximately [redacted]. Voith's market share is approximately [redacted] or [redacted] per year. From publicly available information, I estimate AstenJohnson's market share to be approximately [redacted] per year.

9. JohnsonFoils' Infringing Rebuilds and their pricing structure have [redacted]. As a result, Voith has also lost opportunities to market other parts, services, and accessories, such as forming fabrics.

10. The impact of JohnsonFoils' Infringing Rebuilds on Voith's market share [redacted]. Of the [redacted] gap forming sections of paper making machines worldwide, specifically so called gap formers and gap-roll-formers, rebuilds have been performed on [redacted]. Voith has performed [redacted] of these rebuilds [redacted] and JohnsonFoils has performed [redacted]. However, in the United States, [redacted], JohnsonFoils' Infringing Rebuilds have [redacted]. Because of the large market potential in the United States, [redacted], JohnsonFoils' Infringing Rebuilds, if permitted to continue unabated, are expected to impact [redacted] such rebuilds as well as the parts, services, and accessories which are often sold to a customer subsequent to a successful rebuild.

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11. Upon information and belief, including communications with paper manufacturers and publicly available information, Voith's loss of opportunities [redacted] is directly attributable to JohnsonFoils' lower prices. I estimate that JohnsonFoils prices the Infringing Rebuilds [redacted] less than Voith and other market competitors such as Metso Paper, Inc. ("Metso"). For example, Voith is aware, [redacted] that JohnsonFoils has used its low pricing strategy to win contracts for performing the Infringing Rebuilds. [redacted].

12. Prior to its recent entry into the paper former rebuild business, JohnsonFoils was known as a supplier of paper machine components, such as, for example, suction boxes, foil boxes, ceramic covers, and blades. [redacted].

13. Upon information and belief, JohnsonFoils' ability to offer reduced prices is related to its pattern of copying paper forming technology from companies, primarily Voith, who must incorporate the significant costs of research and product development into their pricing structure. Instead of bearing the expense of developing the considerable technological know-how needed to perform such rebuilds, JohnsonFoils has instead relied on copying Voith's

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published innovations, including the technology disclosed in the Patents-in-suit, and hiring individuals who have obtained technological know-how from Voith and other companies. For example, JohnsonFoils hired James A. Ronning, [redacted].

14. Based on my experience in the paper manufacturing industry, the loss to Voith resulting from JohnsonFoils' continued infringement of the Patents-in-suit far exceeds the revenues directly relating to the Infringing Rebuilds. In the paper manufacturing industry, it is understood that successfully performing a rebuild often leads to subsequent sales of paper making machinery, parts, supplies, and services unrelated to the original rebuild. For example, subsequent sales often include [redacted]. These additional items may be considered unrelated to the subject matter of the Patents-in-suit.

15. Sales of paper forming fabrics, also supplied by Voith, [redacted] result from performing a successful rebuild. Based on my experience, [redacted]. These fabrics are replaced [redacted] per year. Apart from the follow-on sales of other parts, accessories, and services, revenue from the follow-on sale of fabrics would add revenue of [redacted]. However, because performing a successful rebuild may result in the opportunity [redacted], the actual revenue from additional fabric sales could be much greater. Adding to the significance of this sum, [redacted].

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16. As explained above, the market for fabrics alone is estimated to be approximately [redacted]. The global market for services relating to paper making machines is greater than [redacted]. Of this, Voith currently has at least an [redacted] share of the services market or [redacted].

17. For example, [redacted], Voith rebuilt the forming section at a paper making machine installation known as [redacted]. Although the cost of the core rebuild was only [redacted], Voith was also asked to supply several additional services, including [redacted]. Thus, in addition to the [redacted] cost of the core rebuild, this contract provided Voith with revenues of [redacted], for a total of [redacted]. In addition, performing this rebuild successfully resulted in [redacted] sales amounting to [redacted] per year [redacted]. The [redacted] sales alone are expected to provide Voith [redacted]. In this example, without considering other opportunities to perform subsequent rebuilds, or to replace the paper machine itself at the end of its useful life, the original revenue from the core rebuild [redacted] is only [redacted].

18. An additional illustration is provided by the rebuild performed by Voith at [redacted]. This rebuild was performed on [redacted], a paper making machine originally manufactured by [redacted]. This rebuild is very similar to

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the type of rebuild suitable for the BelBaie [redacted]. Although the cost of the core rebuild was only [redacted] Voith was also asked to supply several additional services, including [redacted]. In addition, [redacted] also asked Voith to perform unrelated rebuilds on the [redacted] section of the [redacted] In the [redacted] section, [redacted] ordered a [redacted], together with other modifications totaling approximately [redacted], and [redacted]. In the [redacted] section, [redacted]. In addition, parts for a [redacted] were provided. Thus, in addition to the [redacted]) for the core rebuild, this contract provided Voith with further revenues of [redacted], for a total of [redacted]. In addition, [redacted] has made fabric purchases which are expected to provide Voith with estimated annual revenues of [redacted] for [redacted] and [redacted] for [redacted]. The [redacted] sales alone are expected to provide up to [redacted] in additional revenue for [redacted] period. In this example, without considering other opportunities to perform subsequent rebuilds, or to replace the paper machine itself at the end of its useful life, and [redacted], the original revenue from the forming

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section rebuild [redacted] is only about [redacted] of the total expected revenue stream [redacted]

19. A further typical illustration of other sales resulting from providing forming section rebuilds is provided by the rebuild performed by Voith at [redacted]. Although [redacted] was primarily interested in a rebuild of its forming section, [redacted] ultimately ordered a [redacted] section as well. Thus, in addition to [redacted] from the sale of a forming section and rebuild parts of [redacted], further revenue was obtained from the sale of the [redacted]. Additional parts and services from this rebuild, such as [redacted], ultimately provided further revenues of [redacted]. Thus, obtaining the contract for the forming section rebuild for [redacted] resulted in additional sales revenue of [redacted]. Considering these additional revenues, and without regard to future opportunities [redacted], revenue from the forming section rebuild that drove this deal amounted to [redacted] of the total revenue from this transaction.

20. Yet another example is provided by the previously mentioned [redacted] performed by Voith for [redacted]. In that instance, Voith's successful performance of a rebuild [redacted] resulted in the subsequent sale of a completely new paper machine, namely [redacted]. In my experience, it is typical that successfully performing a rebuild results in subsequent sales which may be functionally unrelated to the original rebuild.

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21. In view of the preceding examples, and based upon my experience in the paper manufacturing industry, JohnsonFoils' continuing infringement of the Patents-in-suit causes damages to Voith [redacted] the charges directly related to the infringing rebuilds at issue in this Infringement Litigation. The operating life of a paper machine is potentially unlimited if regular maintenance, including possible rebuilds in accordance with the rebuild cycle, is performed. Because these damages are difficult to quantify in advance and may not be compensable under United States law, Voith's damages are irreparable. The only effective means of avoiding further irreparable harm is to obtain an injunction preventing further Infringing Rebuilds following a speedy adjudication of this Infringement Litigation.

22. I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on February 13, 2008

_____
Karl-Josef Böck

# EXHIBIT 2

*PAPTAC 94th Annual Meeting*
*Paper Machine Technology Session, Feb. 6, 2008*

# Evaluation of Gap Forming Rebuild Options: Part I - Quality Improvements with Maximum Reuse of Existing Drainage Components

V. J. Wildfong
J. A. Shands
J. Ronning
M. Condon
M. Bouchard
J. P. Lajoie

**Abstract**
With ever increasing quality and production requirements, paper mills are looking for improved formation and sidedness characteristics from their vintage gap formers as well as production increases. A bladed gap former rebuild is presented that offers significant paper quality improvements while maximizing reuse of existing drainage components. Changing blade widths and adding counterblades can lead to significant formation and sidedness improvements. Pre couch vacuum box additions can lead to increased capacity and be used for sidedness tuning. To illustrate the opportunities available, a numerical model of the early drainage process is run and examined. Rebuilds of three newsprint machines running different furnishes are reported on. Rebuild performance was evaluated relative to sheet structure including Ambertec formation, total fines and mineral fines sidedness, porosity, and roughness sidedness. The effect of the rebuild on CMD basis weight profiles and end user performance are also discussed.

## Introduction

Gap forming of paper grades can be broadly categorized as occurring by one of two methods based upon jet trapping and the fluid mechanics of early mat formation and drainage. Blade forming traps the headbox jet between two fabrics, typically with the jet landing onto one fabric prior to a bladed assembly, with the constrained slurry and two fabrics wrapping a series of blades assembled in a curved forming shoe immediately after trapping. Fabric tension and deflections over the bladed assembly provides pulsating shear and a driving force for initial dewatering to occur. Roll forming allows for jet impingement onto a forming fabric wrapping a suction forming roll with a second fabric constraining the slurry over the roll. Both fabrics then move over the rotating suction forming roll with the slurry between them and the deflection of the wires over the roll provides a more "constant" driving force for initial drainage. Both types of configurations have advantages and disadvantages.

The use of pneumatically loaded counter blades in the drainage and forming area has become the industry standard for many grades. Either types of formers, regardless of initial forming element, either blade or roll, could potentially benefit with the addition of counterblades opposite a stationary bladed assembly. The use of these pneumatically loaded counterblades on three commercial newsprint machines configured as blade formers is examined. The machines were rebuilt to provide improved quality and capacity to approach configurations of current industry best practice, while still reusing a majority of the existing drainage components.

**Theoretical**

During twin wire forming over a bladed assembly, the fabric deflection is determined by the spacing and blade width of the fixed blades and the radii of the curvature that they are located upon. Loadable counterblades mounted opposite of a fixed bladed assembly provide an additional tool for increased and variable pressure pulses and shear due to increased and variable fabric deflection. This deflection not only occurs at the counterblade itself, but also at the trailing edge of the proceeding fixed blade and at the leading edge of the subsequent fixed blade. Numerous models have been published in recent years to calculate the pressure pulses of both fixed, curved bladed assemblies and also fixed assemblies with counterblades mounted opposite to them (e.g., see references 1-8).

The models typically represent the geometry of the forming zone and three physical processes: the fluid dynamics of the un-drained slurry trapped between two forming fabrics, the transverse deflection and corresponding location of the fabrics, and the drainage and mat building on each fabric. The drainage and mat building is modeled as flow through porous media with a resistance coefficient that changes based on mat thickness and pulp type. The geometry of interest is broken up into a series of elements and the series of differential and algebraic equations solved simultaneously.

Two equations account for the deflections ($y_i$) of fabrics 1 and 2, when dewatering occurs under tension ($T$) in the two fabrics and the fluid wedge is acted upon by an external force, as given in Equations (1), neglecting bending stiffness . The tension in the fabrics and the external force create a pressure ($P$) within the fluid. The pressure external to the two fabrics is given by the symbols $Pa_1$ and $s$ is the horizontal co-ordinate.

Deflection of Fabric 1

$$T\frac{\partial y_1^2}{\partial s^2} = \left(P - Pa_1\right) \tag{1}$$

Deflection of Fabric 2

$$T\frac{\partial y_2^2}{\partial s^2} = -\left(P - Pa_2\right) \tag{2}$$

The equation for conservation of mass, Eq. (3), is the continuity equation written in terms of the slurry velocity ($u$) and drainage velocities for the fluid moving between the furnish particles and the two fabrics ($W_1$ *and* $W_2$). This equation accounts for the loss of mass from the slurry because of drainage and thickening that is occurring between the two fabrics.

$$\frac{d}{ds}\left[u(y_2 - y_1)\right] = -(W_1 - W_2) \tag{3}$$

The momentum equation, neglecting viscous forces is given in Eq. (4). Here gravity is included, but it is often not a major factor. This equation is actually a form of Euler's equation.

$$\frac{dP}{ds} + \rho u\frac{du}{ds} + \rho g\sin\theta = 0 \tag{4}$$

The pressure drop across the mat is assumed to follow Darcy's law in terms of the drainage velocity ($W$) and mat thickness ($d$).

$$\frac{(\Delta P)_{mat}}{d} = a_1 W \tag{5}$$

The pressure drop across the fabric is assumed to follow a quadratic relationship to include the inertial effects associated with the higher velocity initial drainage through the fabric.

$$(\Delta P)_{Fabric} = a_o W + b_o W^2 \qquad (6)$$

**Machine Configurations**

This paper examines the effect of a rebuild of a blade type gap forming arrangement on three commercial newsprint machines. The machines were rebuilt to provide improved quality and capacity to approach configurations of current industry best practice, while still reusing a majority of the existing drainage components. The scope of supply is characterized by three main components: Frictionless Counterblades™, custom ground ceramics for the forming shoe and suction box, and addition of a Pre-Couch Hivac™. Further options that fall under this approach include upgrading of the suction box cover and the addition of a post couch Super HiVac™ unit. The rebuild configuration for one rebuild is depicted in Figure 1.

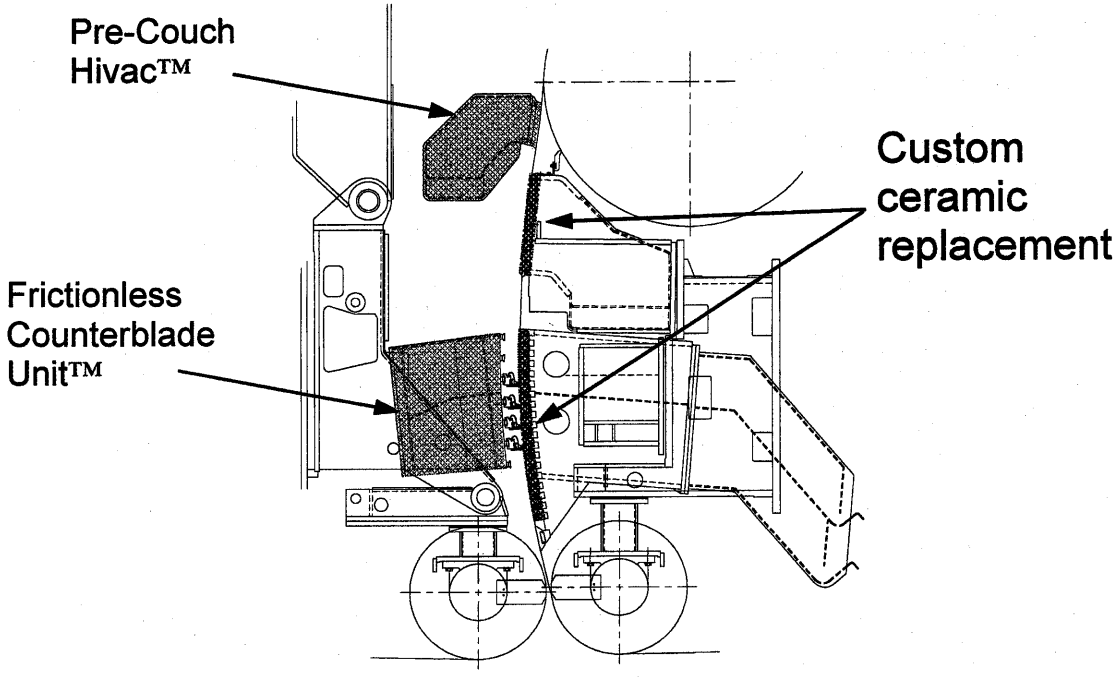


Figure 1. Rebuild configuration showing the addition of a counterblade unit, pre-couch hivac box, and blade/cover replacement with custom ground ceramics.

The counterblades are pneumatically adjustable blades mounted inside the number one fabric opposite the forming shoe. The pneumatic loading and corresponding deflection, pressure between the fabrics, and subsequent shear forces can be adjusted during operation. The increased shear of the counterblades typically improves formation if properly located at the correct consistency during the sheet forming process. Their location inside the backing fabric promotes drainage symmetry which leads to more even-sided sheets. Additionally, they increase fabric support on the backing fabric which promotes improved basis weight profiles.

The example forming configuration shown in Figure 1 is a Bel Baie III blade style gap former which incorporates a number of relatively wide (38 mm) blades with narrow (xx mm) slots over the forming shoe. With this design, the pressure pulses generated tend to mostly occur over the blades themselves rather than the slots, leading to greater drainage away from the shoe than into it. This leads to uneven fines and ash distributions which are not optimal for print quality, dusting and linting, or curl related performance. Replacing the existing blades with a narrow land design over the critical early drainage portion of the shoe will lead to more even-sided drainage as the driving force for the dewatering will now occur in front of the blade where two sided dewatering can occur. This will lead to more even-sided mat building and fines and ash distributions. For Bel Baie II style forming shoes, the blades over lower part of the forming shoe which are a narrow land design can be reused, but should be evaluated for wear and replaced with custom ground ceramics if needed.

The Pre-Couch Hivac is also located inside the backing fabric loop and adds extra dewatering prior to the couch. Running drier to the couch is typically associated with improved runnability. Addition inside the backing fabric also promotes improved drainage symmetry by inclusion of high vacuum zone inside both fabric runs.

**Model Results**

To illustrate rebuild principles, forming shoe configurations similar to that before and after the rebuild shown above were numerically modeled for the same initial process conditions.

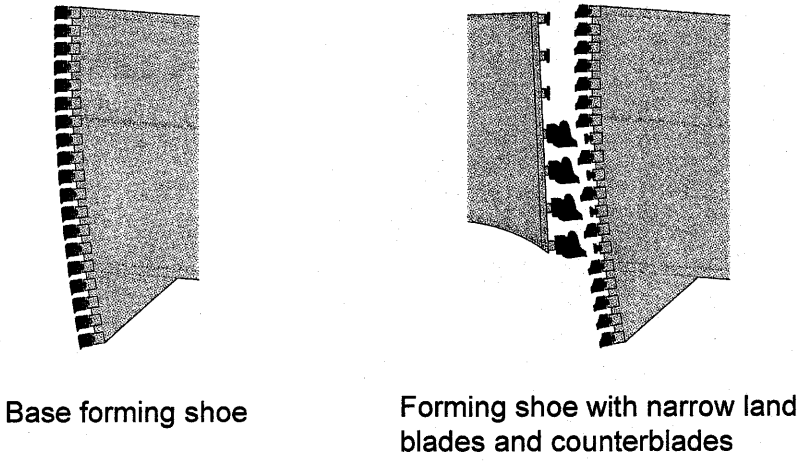


Figure 2. Forming shoe geometries modeled.

The pressure profiles that occur between the fabrics for these two configurations are shown in Figures 3 and 4. The higher peak pressures generated by the counterblades can be clearly seen.

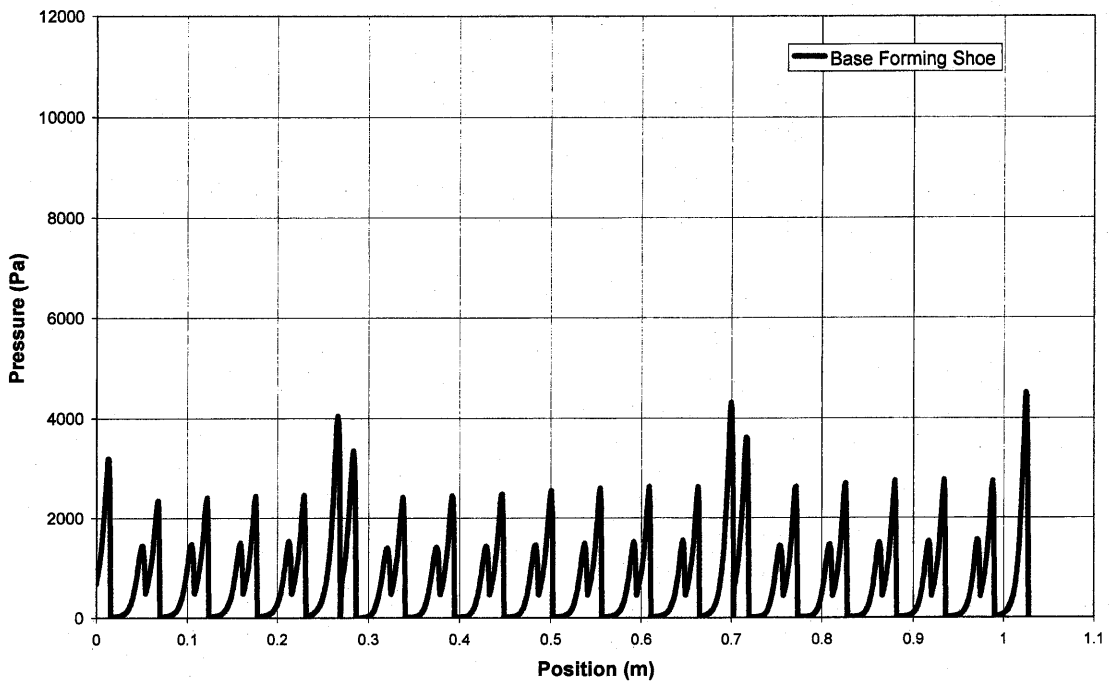


Figure 3. Pressure profile with base forming shoe.

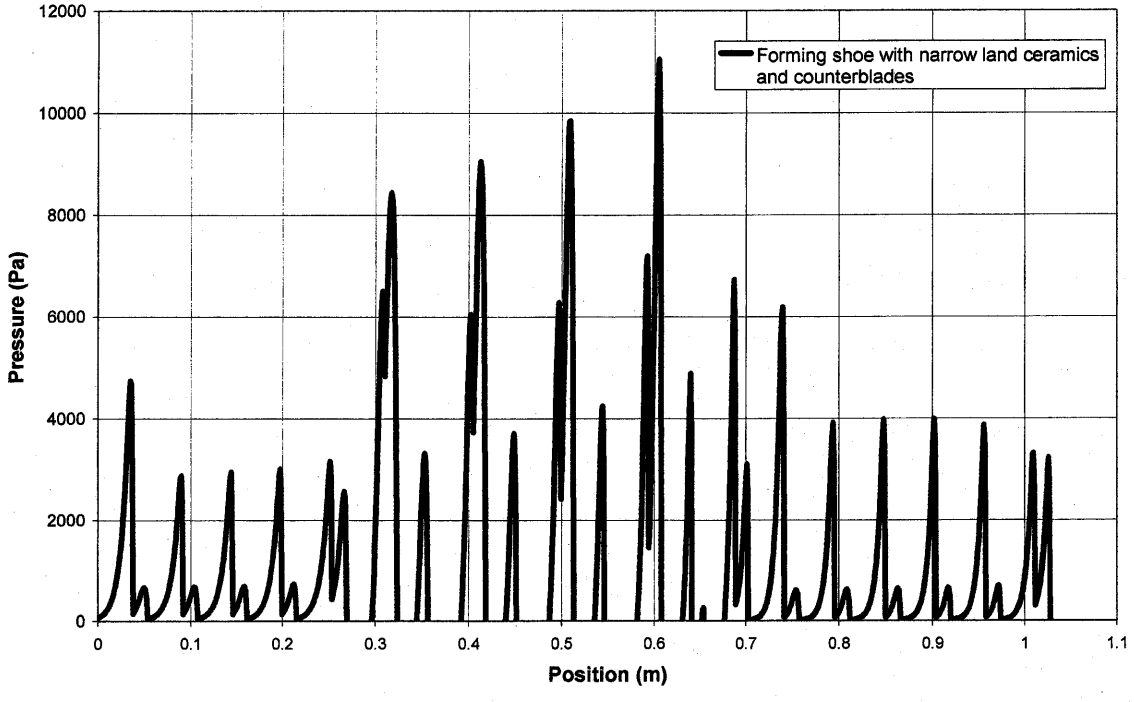


Figure 4. Pressure profile for forming shoe with narrow land blades and counterblades.

Drainage rate to each side and mat thickness following the shoe are listed in Table 1. Total drainage and increased drainage symmetry is evident in the model output.

Table 1. Model drainage output.

| | Flow Rates (gpmi) | | | Drainage Splits on Shoe | |
|---|---|---|---|---|---|
| | Base Forming Shoe | Forming shoe with narrow lands and counterblades | Change with modifications | Base Forming Shoe | Forming shoe with narrow lands and counterblades |
| Backing side | 6.5 | 10.0 | +3.5 | 59% | 56% |
| Conveying side | 4.5 | 12.0 | +7.5 | 41% | 44% |
| Total | 11.0 | 22.0 | +11.0 | | |

**Furnish Characteristics**

The basic furnish types and drainage characteristics for the three commercial machines being reported on are listed in Table 2. The locations of the counterblades in the machine direction are dependent on the detailed fiber and mat building characteristics such as fiber length and filtration resistance.

Table 2. Furnish characteristics for rebuilds reported on.

| Mill | Furnish Designation | Headbox Freeness (csf) | Headbox Consis. (%) | Headbox Fines (%) | Specific filtration resistance at 20 gsm ($g/cm^3 \times 10^5$) | Fiber Length l-weighted (mm) | Fiber Length wt-weighted (mm) |
|---|---|---|---|---|---|---|---|
| Mill A | Asian recycle | 51 | 1.0 | 50 | 22.2 | 0.80 | 1.13 |
| Mill B | N. American recycle | 35 | 0.8 | 57 | 62.4 | 1.32 | 2.17 |
| Mill C | Groundwood and TMP | 70 | 1.1 | 54 | | 0.97 | 1.45 |

**Sheet Characterization**

The sheets of paper produced on these commercial machines have been documented before and after the rebuilds. A variety of properties were examined including Ambertec formation, fine material sidedness, roughness sidedness, and porosity.

Effect of Forming Zone Modification on Ambertec Formation

The impact of the rebuilds on sheet formation is reported in Figures 5 and 6. Ambertec formation in standard $g/m^2$ units is shown in Figure 5. Specific Ambertec formation, normalized to account for basis weight differences when comparing grades of differing weights is shown in Figure 6. For each of the mills, a significant improvement in formation was achieved.

The effect of the number of counterblades and effect of counterblade loading strategy has been previously reported in other publications (6, 9). A general approach is to successively load each of the four counterblades until doctoring occurs, indicating that contact and deflection has been initiated, and then optimizing from there. This approach led to the significant formation improvements seen.

Incorrect application or design of the counterblades and custom ceramics can lead to a decrease in formation and even a crushing defect. The crushing defect is evident when too high a shear force is introduced into the slurry and subsequent mat disruption occurs. This is especially evident for shorter fibered furnishes. It is important to have the correct shear designed into the equipment to provide optimum

formation without excessive shear. The loading mechanism of the counterblades is also an important design consideration, as light gentle loading provides the best formation results. Counterblades that display sticking due to a poor loading mechanism and or poor cleanliness often lead to worse or uneven formation as the ability to control the loading accurately is diminished when sticking of the mechanism occurs.

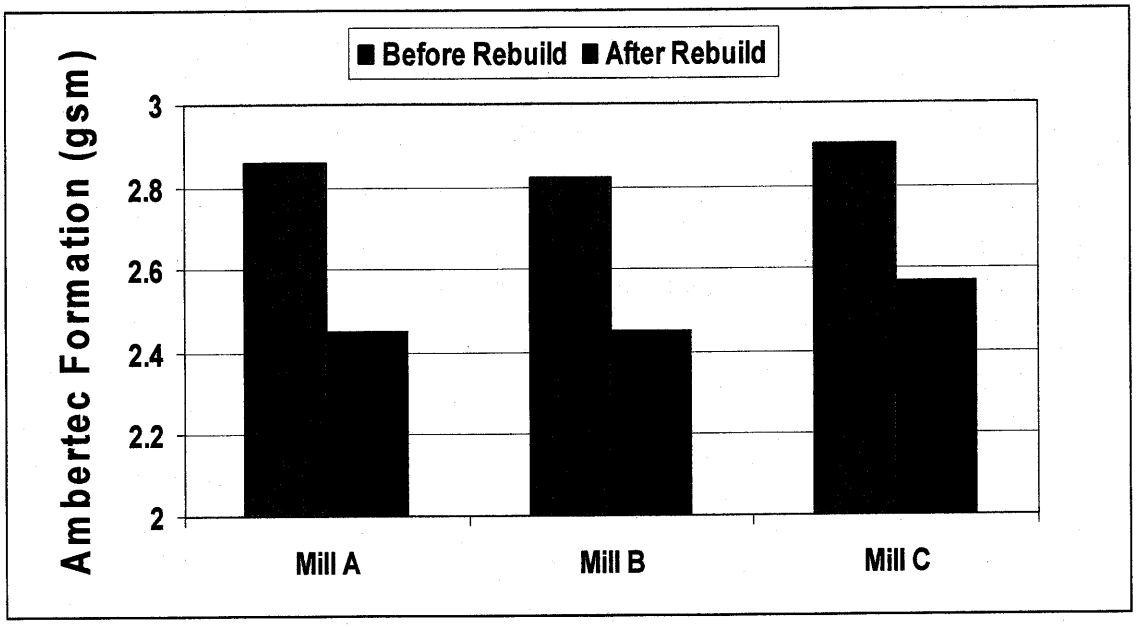


Figure 5. Ambertec Formation.

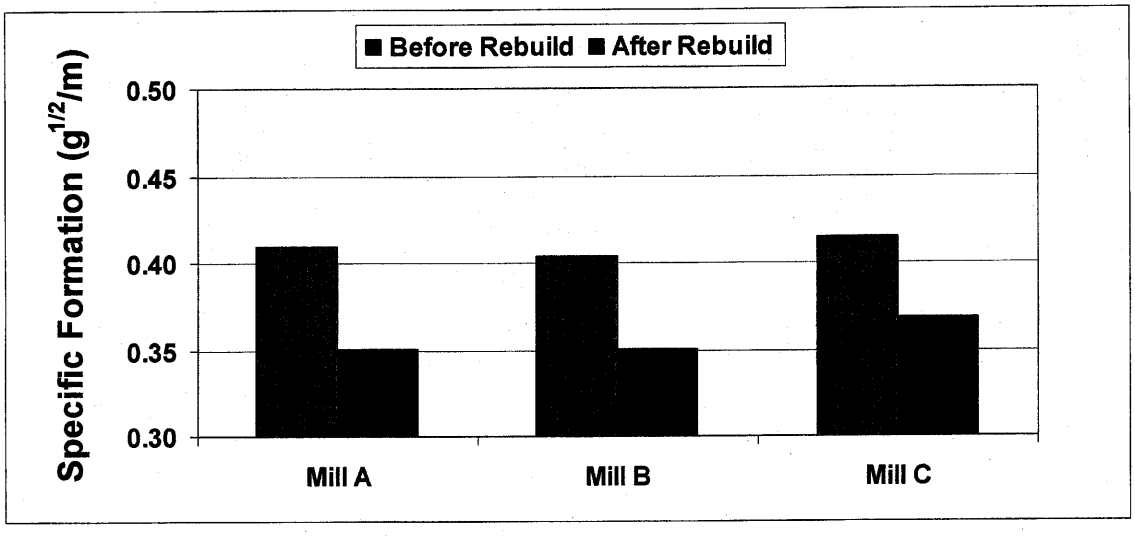


Figure 6. Ambertec specific formation.

Effect of Forming Zone Modification on Fines and Ash Sidedness

The rebuild provided significant improvements in fines sidedness as depicted in Figure 7. Typically, Bel Baie made newsprint is asymmetrical with about 4%-8% higher fines on the top side, which was case for these rebuilds. These sidedness differences were reduced by greater than 50% with top side fines becoming about 2%-3% higher than the bottom side. In Figure 8, ash sidedness before and after the rebuilds is shown. Similar to fines, the top to bottom ash differences are reduced.

The fines are ash distributions are primarily developed through the filtration process. The more mobile finer material will tend to move with the flow and become entrapped in the outer layers of the mat as it is formed. There are a number of factors influencing this process, with the amount of flow to each side being a critical one. The improvements seen in the fines and ash distributions in the rebuild configurations are most likely primarily due to the more symmetrical dewatering occurring over the forming shoe from the combination of the custom ceramic blade replacement and counterblade applications.

The Precouch Hivac can also impact distributions, with a greater impact on ash. This unit is placed within the backing fabric loop. The sheet consistency into this unit is most likely 5-7% for these grades. The fluid core between the fabrics and each mat deposited on the fabric is probably very small or non-existent at this point in the forming process. The dewatering mechanism is no longer filtration, but consolidation of the web. During consolidation, the fine material transfer during dewatering is likely a removal process. The high velocity drainage that occurs at the higher vacuum levels after the sheet is consolidated may cause stripping of deposited fine material near the surface. Having the higher vacuum elements such as the suction box, pre couch hivac and post couch super hivac within alternating fabric loops promotes symmetrical sheet building and exposes both sided of the sheet to high vacuum, higher velocity drainage compared to pre-rebuild conditions.

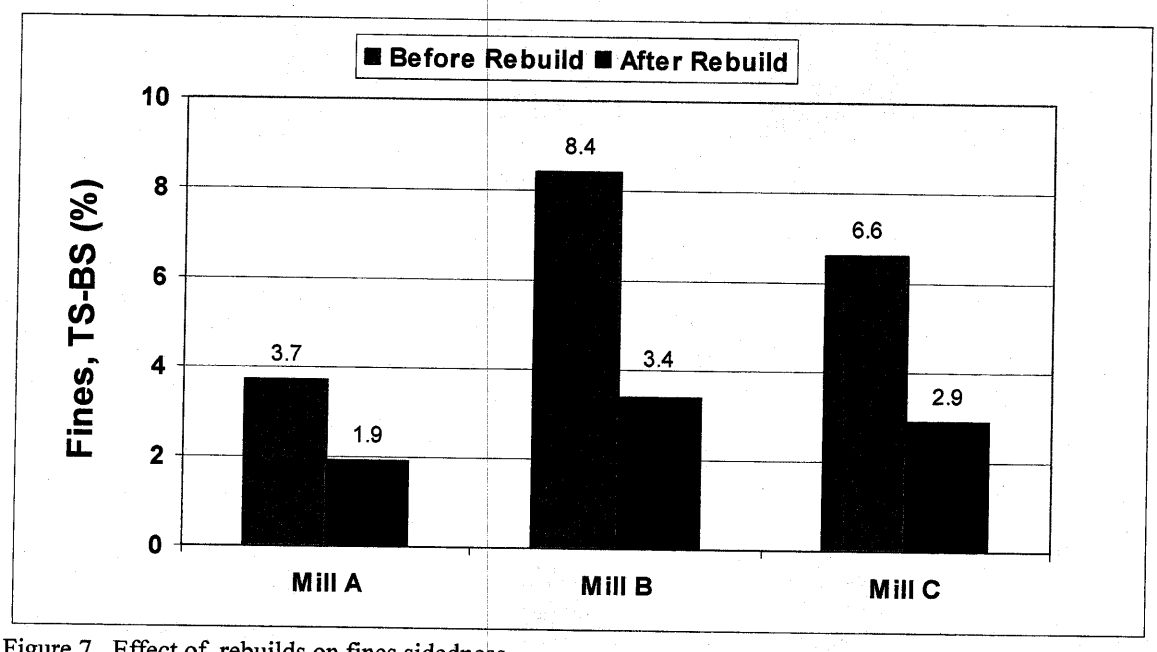


Figure 7. Effect of rebuilds on fines sidedness.

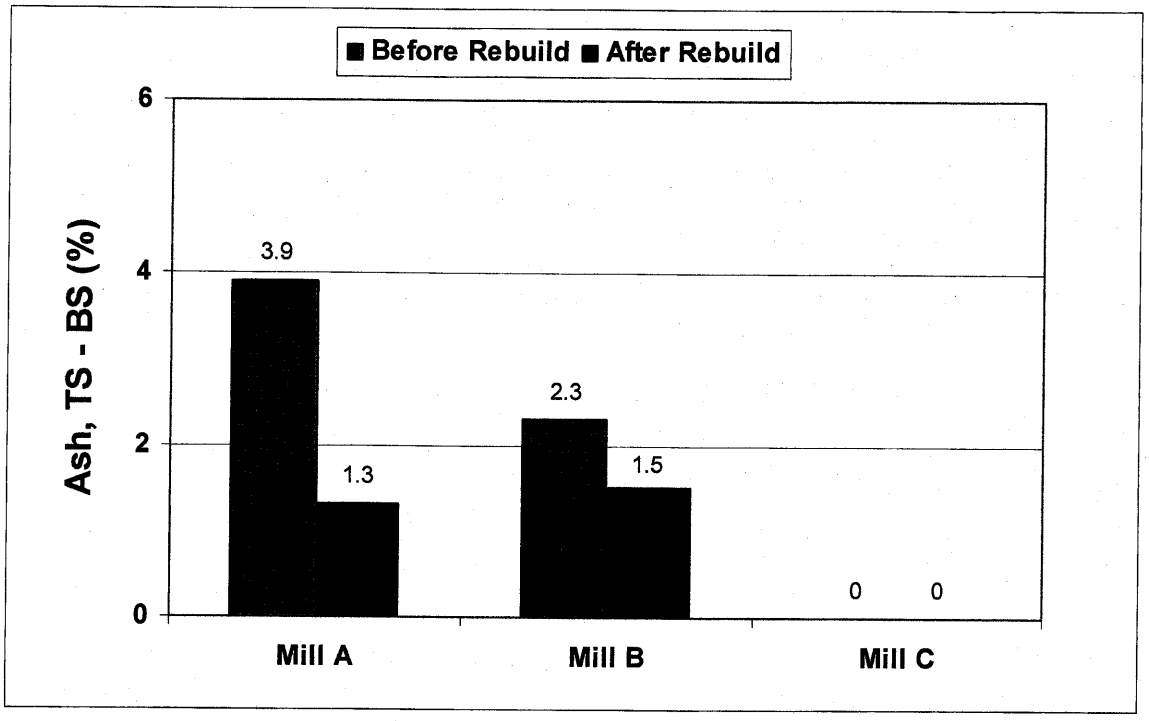


Figure 8. Effect of rebuilds on ash sidedness.

Effect of Forming Zone Modification on Smoothness Sidedness,

The smoothness of paper produced on a machine depends on a variety of factors including formation and scale of formation, fine material sidedness and location near the surface, forming fabric selection, press configuration, loadings, and felts, and calendar configuration and operation. Overall smoothness improved for all three rebuilds. This is to be expected with the level of formation improvement that occurred with these rebuilds. Additionally, the smoothness sidedness also improved. Roughness sidedness and total fines sidedness values are given in Table 3. The press and calendar configuration are also included due to their significant influence on final properties.

Table 3. Effect of rebuild on Parker Print Surf (PPS) roughness sidedness

| | PPS T-B Before | PPS T-B After | Fines T-B Before | Fines T-B After |
|---|---|---|---|---|
| Mill A | -0.30 | -0.20 | 3.7% | 1.9% |
| Mill B | -1.05 | -0.25 | 8.4% | 3.4% |
| Mill C | -1.15 | -.065 | 5.6% | 2.9% |

Effect of Forming Zone Modification on Air Permeability (Porosity)

Porosity can be influenced by a number of competing mechanisms. The increased drainage velocity and shear associated with the counterblades and Pre-couch HiVac might reasonably be expected to lower retention and open up the sheet (become more porous). However, two out of the three rebuilds demonstrated a more closed sheet after the rebuild. This can be attributed to the significant improvement in basis weight distribution that occurred with the rebuild. The dominant mechanism is the formation improvement when significant changes occur. The more uniform sheet structure typically will create a slightly more closed sheet after the rebuild when compared to before the rebuild even under higher shear and higher drainage velocity conditions. This has also been evident in other rebuilds, both newsprint and fine paper, not reported on in this paper.

Table 4. Sheet porosity before and after the rebuilds.

| | | Before rebuild | After rebuild | |
|---|---|---|---|---|
| Mill A | Bendtsen Porosity (ml/min) | 255 | 240 | 6% more closed |
| Mill B | Gurley Porosity (sec) | 37 | 39 | 5% more closed |
| Mill C | Bendtsen Porosity (ml/min) | 120 | 135 | 11% more open |

Machine Speeds

Before and after machine speeds are listed in Table 3. For mill A, the primary goal of the rebuild was quality and not a production increase. For mills B and C, production increases were targeted and post couch Super HiVac boxes were added for additional capacity to assist in achieving production increases.

Table 5. Machine speeds before and after the rebuilds.

| | Before Rebuild | After Rebuild |
|---|---|---|
| Mill A | 1150 mpm | 1200 mpm |
| Mill B | 1200 mpm | 1340 mpm |
| Mill C | 1125 mpm | 1450 mpm |

Effect on cross machine basis weight profiles

The addition of counterblades will provide more support to the outer fabric over the forming shoe, which will help improve cross machine basis weight profiles. The amount of improvement will of course depend on level of variation before the rebuild, the type of fabric being run, and other process and operating conditions. The largest improvement seen to date has been a 60% improvement in 2 sigma values.

Effect of Forming Zone Modification on Printing Performance and Curl

Providing more closed up surfaces through better formation and fines distributions will lead to enhance print quality as well as enhancing surface strength that will reduce dusting and linting. Improved fines sidedness reduces the differential response to moisture and heat changes, reducing curl.

**Summary**

A gap former rebuild is presented that offers significant paper quality improvements while maximizing reuse of existing drainage components. The machines were rebuilt to provide improved quality and capacity to approach configurations of current industry best practice, while still reusing a majority of the existing drainage components. The scope of supply is characterized by three main components: Frictionless Counterblades™, custom ground ceramics for the forming shoe and suction box, and addition of a Pre-Couch Hivac™. The results for three commercial newsprint machines are examined. Significant improvements in formation are reported along with fines, ash, and smoothness sidedness leading to improved end user performance.

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